Index to Appendix

	Page
Other Cognate Patents and Publications	1
German patent to Kolsche. (Defendants' Exhibit 168, p. 657 Exh. Book; See Photostat Enlargement.)	1
Butler, No. 660,946, Oct. 30, 1900	4
Grout machines, concrete machines, sand blast machines, pneumatic dredgers are all interchangeable	5
Goodridge, No. 317,337, May 5, 1885. (p. 491 Exh. Book.)	6
Goldie patents, 676,128, June 11, 1901. (p. 497 Exh. Book.) 676,129, June 11, 1901. (p. 505 Exh. Book.)	6
Moir, 778,878, Jan. 3, 1905. (p. 519, Exh. Book.)	6
Compressed air in caisson work	8
Pneumatic painting	8
Church, No. 487,606, Dec. 6, 1892. (p. 623, Exh. Book.)	9
Rix et al, 635,270, October 17, 1899. (p. 617, Exh. Book.) Dredging machinery	11
Prior uses in analogous work	11
Miami depositions	12
Dredging by steam pressure	12
Cement a lubricant	14
Witness identifies an article in "The Railroad Gazette" for April 20, 1906. (Miami Exhibit 15-A.)	14
Witness identifies the Hussey patents as corresponding to the dredgers	15
Material more difficult of handling than concrete	18
Depositions at Sulphur, La. (R. 155-197)	18
Conveying molten sulphur by compressed air. Frasch, No. 799,642, Sept. 19, 1905. (Application filed May 27, 1897.) No. 800,127, Sept. 19, 1905. (Application filed Nov. 23, 1903.)	20
Compressed air the only practical method	20
Difficulties of handling sulphur	21
"Slug" or "piston" action always present in pumping sulphur	21
Frizzell and Pohle methods contrasted	23

Page

Crowley, La. depositions. (R. 197-218.) 24

Deposition of Edmund M. Ivens, New Orleans, taken September 1, 1927, a noted engineer in water lift work..... 26

Wide variety and use of air lift..... 27

No difference in action whatever the material..... 27

Abstract of exhibit publications 27

Pneumatic sewage system..... 28

Grouting by compressed air..... 29

Compressed air for injecting cement into quicksands and for consolidating foundations..... 37

Appendix

OTHER COGNATE PATENTS AND PUBLICATIONS.

Prolific as is the art of conveying liquids and semi-liquids by compressed air, we shall refer to only a few of the many pertinent examples.

The following patents should not be overlooked:

GERMAN PATENT TO KOLSCHE. (Defendants' Exhibit 168, p. 657 Exh. Book; See Photostat Enlargement.)

This type of apparatus for sand blasting bears a marked structural resemblance to McMichael.

There are several patents on which the apparatus claims of McMichael read exactly word for word. We refer mainly to German patent to Kolsche, No. 18,394, dated October 16, 1881, particularly as the trial judge appreciated its pertinence as an anticipation.

It employs a closed receptacle to contain the material, and acted by **air pressure on the mass and a syphon air jet in the discharge pipe.**

Its only difference from McMichael is that with it the sand is **dry** or moist while in McMichael the sand is **wet.**

We invite the Court to compare McMichael's claims in suit with this structure and see how apt the language is to it.

The German patent cited above shows everything in the McMichael patent and claims, including the receptacle with the **smooth tapered bottom** (as of claims 21,

22, 34, 35) and the "relatively large" discharge pipe (claim 5) or "relatively extended passageway." (Claim 8.)

Plaintiff's attack on the Kolsche patent simply emphasizes its pertinence as an anticipation as found by Judge Bourquin. Plaintiff gives a translation of the Kolsche specification at pages 100-101 of its brief, for which we are indebted, and shows how faithful a picture this is of McMichael's apparatus. To quote from Kolsche:

> "The receptacle **b** is filled with the material through opening **k**, the cover of the latter is closed, lever mechanism **q n m** is actuated and the main air supply valve in front of **a** and valve **g** opened. The latter is done, so that the same air pressure prevails above the mass to be moved as below it, and so that it will drop unobstructed into the air pipe **d**. Receptacle **b b**^{1} is filled only up to the air passages **g g**^{1}. When the particles drop they are engaged in pipe **d** by the air current and driven through the entire passage."

Regardless of plaintiff's pretentions to the contrary, this latter air jet is a true "velocity jet."

Compare this with the description and illustration of the **McMichael** apparatus as the same appears in the "Engineering News" article of August 10, 1911, reproduced in the McMichael file wrapper (pp. 269-271 Book of Exhibits) and filed in the Patent Office by the attorneys for plaintiff in contending for novelty for McMichael:

> "The chamber (in McMichael; see illustration) has two 1½-in. pipe connections for the admission of compressed air. The horizontal pipe (E) admits air to the top of the chamber, immediately

below the inlet valve. From this pipe is a branch (F) terminating in a horizontal nozzle fitted to the back of the elbow casting. The air is admitted to both points simultaneously, by means of the valve (G). Should it be desirable for any reason to blow air into the pipe only, this can be done by the by-pass (H), the valve (G) then remaining closed.

"The compressed air at 40 to 60 lbs. pressure forces the contents of the chamber down to the elbow (this movement taking only one or two seconds), where it is struck by the horizontal jets," etc.

Concerning Kolsche, Judge Bourquin said:

"The third is **Kolsche's German patent** 18,394 of 1882, for 'apparatus for conveying substances, slack, sandy, or granular material, by means of a current of air.'

"The apparatus is like McMichael's without the U bend; that is, it is an upright cylindrical container, with hopper bottom terminating in a discharge pipe. Compressed air is applied above or behind the material in the container, to force it down and into the discharge pipe, and at that point like air is admitted to assist driving the material through the pipe.

"Without any change, perhaps, save adjustments to circumstances as always, Kolsche's apparatus and method will transport concrete as does McMichael's. Kolsche could rightfully devote it to that analogous use. It follows that McMichael's essentially unchanged application of Kolsche to analogous materials and uses, is not invention. In principle, essential design, function, operation, object and result, Kolsche and McMichael are one and the same. Either reads on the other.

"Kolsche, if later and devoted to concrete, might infringe McMichael, and by the same token, being earlier, he anticipates him.

"The same is true of Duckham, especially in respect to McMichael's application originally, and their common use of the lower air to prevent or relieve packing of the material.

"It must be remembered that the test of 'analogous uses' is not from whence comes and where goes the materials, to what ultimate end or use, or their nature, but in the *method* of conveyance. **Although fertilizer and flour be unlike, and for ends as wide apart as the poles, a wheelbarrow conveying both is devoted to analogous uses, in patent law.**" (Boldface ours.)

BUTLER, NO. 660,946, OCT. 30, 1900.

This patent is a good illustration of the interchangeableness of a **sand** blast and a **water lift,** both employing compressed air for conveying.

The inventor shows and describes both forms. He says:

"The object of my invention is to provide an apparatus operated by compressed air to elevate and discharge sand, water, etc.

"The principal object of my invention is to provide an apparatus for emptying sandboxes of locomotives.

* * * * * * *

"**The particular sand-pump which I have invented could, however, be used for elevating water or other substances, as will be hereinafter described.**"

* * * * * * *

"**Fig. 2 is a similar view of my apparatus as applied to a well.**"

That shows as well as anything could that it did not require invention in McMichaels to adapt the specific showing of the German patent for example, to the blowing of **concrete.**

Plaintiff evidently desires to create the impression that a "pump" is necessarily of the intermittent pulsating or reciprocating type.

The Standard Dictionary defines the noun pump as follows:

> "Pump, (n) (1) a mechanical device for raising, circulating, exhausting, or compressing a fluid by drawing or pressing it through aperatures and pipes. * * *
>
> Pneumatic p. (a pump adapted for compressing, forcing, exhausting or moving air; also one in which a liquid or a semi-solid is transported by the pressure of air or other gas in a closed vessel, forcing it along a pipe). * * * *"

"Flowability" is, of course, as essential in successful pumping by air pressure whether it is water or concrete.

GROUT MACHINES, CONCRETE MACHINES, SAND BLAST MACHINES, PNEUMATIC DREDGERS ARE ALL INTERCHANGEABLE.

This is illustrated in present-day practice in the ready interchangeability of the Hackley (defendants' gun) for shooting grout or shooting concrete—see photograph Exhibits 180 and 182. There is also the testimony that the Canniff machine Exhibit 179 of the San Francisco tests is able to shoot and has actually shot concrete.

These things are conclusive proof of invalidity of McMichael.

Similarly if the McMichael or Hackley guns were to be used in **dredging** operations, it would be necessary only to increase the size of the tank, and instead of a

two-inch pipe as for grout, or a four, six of eight-inch pipe for concrete, one would use a 15 or 18-inch discharge pipe to take larger rocks and great quantities of spoil.

The principle is the same in every case.

GOODRIDGE, NO. 317,337, MAY 5, 1885. (p. 491 Exh. Book.)

METHOD OF REPAIRING WITH BETON OR CONCRETE.

The invention of figs. 1, 2 and 3 is shown as particularly applied to **lining tunnels** and the patent is chiefly interesting in showing a **concrete lined** tunnel as far back as 1885.

GOLDIE PATENTS, 676,128, JUNE 11, 1901. (p. 497 Exh. Book.)
676,129, JUNE 11, 1901. (p. 505 Exh. Book.)

These patents are related, one referring to the apparatus and the other to the matter of injecting liquid cement or wet concrete under railway ties.

The apparatus is somewhat more fully illustrated and described in the 2nd patent.

MOIR, 778,878, JAN. 3, 1905. (p. 519, Exh. Book.)

Application filed July 7, 1904:

APPARATUS FOR FORCING LIME GROUT, CEMENT, OR THE LIKE.

We have already referred to this patent earlier in this brief.

This is a horizontal type of gun quite similar to present day styles. It uses a piston instead of air as an impelling force, although it combines a "hydro-pneumatic action." Some of our present day concrete guns use both the piston and the air.

The patentee Moir says:

> "This invention relates to apparatus which is adapted to facilitate the supply under pressure of lime-grout, liquid cement, or other viscous fluids which have the quality of quickly solidifying for the purpose of filling up vacant space—as, for example, the spaces surrounding the metal sections which forms the lining of tunnels of modern construction."

He then pays tribute to Canniff, McIlvrid, McCormick, Smith and others in the following language:

> "According to the arrangements at present in use for this purpose in tunnel construction a mixing vessel is provided having a cover which is adapted to be opened to receive the materials which compose the grout and to be closed in an air-tight manner after the mixing has been effected. Air under considerable pressure having previously been forced into reservoir by an air-pump driven by an engine or otherwise, a communication is made between the reservoir of air and the upper portion of the mixing-chamber, and the grout is thereby forced through a stop-cock opened for the purpose into a flexible pipe which leads to the place where it is wanted.
>
> Delay in starting the forcing of the grout or any subsequent cessation of the forcing which may occur before the vessel and delivery-pipe are emptied of their contents gives an opportunity for the partial setting of the grout and necessitates the provision of a very considerable pressure in the air-reservoir to overcome the initial resistance on starting or restarting, whereas a

very moderate pressure will in general be sufficient to maintain the flow of grout against the normal working resistance. In consequence of this large, powerful and costly air-pumping appliances are required which are quite incommensurate with the average duty to be performed."

He refers to the hydro-pneumatic action as follows (p. 2, line 22):

"The confined air will interpose itself as a cushion between the hydraulic press and the flowing grout and prevent undue pressure and shock. The operation of forcing the grout will accordingly be due to hydro-pneumatic action.

"At the end of the operation the delivery-pipe can be cleared of its contents by drawing a volume of air or water into the cylinder and discharging it through the delivery-pipe." (p. 2, line 39.)

COMPRESSED AIR IN CAISSON WORK.

Another line of work which is quite similar to McMichael, both in the nature of the materials handled and the principle of operation of apparatus, is in caisson work.

Among leading and very early examples of this in the record are the following:

PNEUMATIC PAINTING.

This was also a well developed art at the time of McMichael. See particularly Saunders' Book (1903), pages 846 to 862, inclusive. (Defendant's Exhibit R, 393 for Identification.)

CHURCH NO. 487,606, DEC. 6, 1892. (p. 623, Exh. Book.)

COATING SURFACES WITH PLASTIC MATERIAL.

This is a Pneumatic Plastering machine.

The patentee says:

> "The invention is designed for the purpose of applying substances in a plastic or approximately-plastic condition to walls, ceilings, or other surfaces."

THE NATURE OF THE MATERIAL.

> "It is essential to my invention that the material be in a soft condition, in which condition it may be forced by an **air-blast or by pressure** directed against the wall or surface which is to be coated. I have found in practice that a good job can be done with an air-pressure of thirty pounds to the square inch. For the best effect I have found that the material should be in a condition a little softer than ordinary plastic material."

He employs a receptacle and air-pressure to force the material from the receptacle through a hose to any desired point.

Exhibit 26: Transactions of the A. S. C. E. July, 1879.

Exhibit 80: Knights Mechanical Dictionary 1873, page 421.

Exhibit 81: Sickles Patent 99,360, Feb. 1, 1870.

Rix Patent: No. 635,270, Oct. 17, 1899, Exhibit 160. (p. 617, Exh. Book.)

Saunders Compressed Air (1903). Defendant's Exhibit for Identification.

Exhibit 33.

Exhibit 26 shows that as far back as 1879 a discussion by Mr. Collingwood in referring to removal of water by compressed air said:

"It is somewhat remarkable that the air pressure was not used also for removing sand and mud, as well as for water."

"The use of a straight pipe without water jet has been found very effective in removing sand, and is certainly more economical when the material is suitable, than the removal by bags."

This article is further interesting as showing the then well known application of compressed air for package conveying.

It is said, page 180:

"When there are boulders, clay or stiff mud, the air can be made to life a cage, acting as a piston in a continuous cylinder which is connected with the atmosphere above (the cage containing the load to be removed). This system is now in successful operation in the Epinac coal basin, in France. Coal is lifted there from a depth of 2000 feet, at a cost considerably less than by the usual method of cables. The miners all ascend and descend by the same apparatus."

Exhibit 80—"Knights' Mechanical Dictionary, 1873" describes and illustrates the Triger method of Caisson sinking.

Exhibit 81, the Sickles Patent is another interesting example of the utilization of compressed air for removing not only water, but **sand, rock** and **gravel** from the interior of a caisson by compressed air.

The same is true of the Rix Patent and the description thereof, in Exhibit 33. See also Sickles Patent 99360, Feb. 1, 1870. (New York Exhibit 81.) Caisson work.

RIX ET AL. 635,270, OCTOBER 17, 1899. (p. 617 Exh. Book.)
DREDGING MACHINERY.

Mr. Rix, one of the inventors, is a distinguished San Francisco engineer who has devoted a lifetime of profitable endeavor in the use of compressed air.

He here utilizes the pneumatic Caisson principle in gold dredging:

He says, p. 1, line 12:

> "This invention relates to subaqueous exploring and excavating in alluvial deposits and over the rock bed beneath in streams, estuaries, bays, or open waters by means of pneumatic or other apparatus."

His invention consists inter alia (p. 1, line 29):

> "means for raising and expelling excavated material by introducing air into the uptake or spoil pipe."

He combines both the "pressure" and the ejector or syphon action of McMichael.

If he encounters **large** rocks too heavy to lift alone by the lighter air pressure he may use a supplemental **water** jet.

PRIOR USES IN ANALOGOUS WORK.

In addition to the foregoing patents and publications defendant found the use of compressed air for conveying various plastic substances analogous to concrete, to have been general and widespread and continuous over many years and in a great number of different localities. Consequently, it was necessary to take depositions at Sulphur, La.; Crowley, La.;

New Orleans, Fla.; Miami, Fla.; New York, N. Y.; Boston, Mass., and Chicago, Ill. A brief résumé of these depositions follow, except as they may have been already covered.

We will take up the Miami depositions first because they refer to the practice of conveying **dredge spoil** by compressed air as in Duckham, supra, only by a somewhat different type of apparatus and on a more gigantic scale.

Mr. Peterson (R. 459) has already told us that **spoil** and **concrete** are quite similar in characteristics when it comes to **consistency** and **mobility.**

MIAMI DEPOSITIONS.

DREDGING BY STEAM PRESSURE.

(Obviously, there is no difference in principle in conveying a fluid or semi-fluid by steam pressure from conveying it by air pressure.)

Philip L. Wilson:

(R. 254):

"I live at 1722 Jefferson Avenue, Miami Beach, Florida. I am a Civil Engineer."

(R. 255):

"I was connected with the Florida East Coast Railway Company from 1904 to 1918."

* * * * * * *

"During the years 1905 and 1906 I had charge of some of the dredges for the Florida East Coast Railway Company which were operated on the Florida Keys.

* * * * * * *

"The object of the dredge work being done at that time was to make embankments or railroad

fills. The nature of the material handled was marl, muck and roots, mostly.

* * * * * * *

"The 'Babcock' and 'Rough Rider' were purchased by the Railway Company from a dredging concern in Georgia. I represented the East Coast at the time the purchase was made. These dredges were towed from Savannah to Miami and later on, down the Keys where they worked at various points. These dredges were purchased by the East Coast Railway Company in 1905."

(R. 255-6):

"The 'Babcock' and 'Rough Rider' are known as vacuum dredges. The first operation, the material to be moved is dug from the bottom of the ocean with a bucket and then deposited into a hopper. From this hopper there is a pipe line to a vertical cylinder about six feet in diameter and 12 feet high. This cylinder is filled with steam. Then water is injected into the cylinder, which condenses the steam and forms a vacuum. A valve is then opened and the material is sucked by the vacuum into the cylinder. This first valve is then closed and live steam under high pressure is let into the top of the cylinder. A second valve is opened and the material is pushed out by the pressure of the steam into a pipe line which runs from the cylinder to the rear end of the dredge, thence through a connecting pipe line to the fill or place where the material is to be deposit.

"At Jewfish Creek the dredge 'Babcock' handled peat, roots and small branches of trees. At Central Supply, which is the opening between Upper and Lower Matacumbe, the dredge 'Rough Rider' handled marl with some shell.

* * * * * * *

"The 'Babcock' carried a fifteen-inch pipe line and the 'Rough Rider' an eighteen-inch.

* * * * * * *

"Marl makes a most excellent roadbed. In general appearance is has a grayish color. After

it has hardened out to a certain extent, it **resembles concrete** or very hard stiff clay."

(R. 257):

"Occasional pieces of rock and conch shells were conveyed with the marl."

CEMENT A LUBRICANT.

(R. 258):

"If you had cement mixed with marl in the way you describe, would that have varied the operation or changed the operation you had?

* * * * * * *

"A. I do not consider that cement would make any difference one way or the other."

(R. 259):

"Many magazines carried articles regarding the construction of the Key West Extension."

WITNESS IDENTIFIES AN ARTICLE IN "THE RAILROAD GAZETTE" FOR APRIL 20, 1906. (MIAMI EXHIBIT 15-A.)

(R. 260-261):

"'A dredge is at work there picking up the peaty bottom of the lake, which is dumped into a hopper and then forced through big pipes supported by pontoon bridges for a quarter of a mile to the point where an embankment for the railroad track across the lake is being built. The only foundation the key offers at this point is mangrove roots. The sections of pipe resting on the pontoons have leather elbows to permit of flexibility. Rattling can be heard in the big pipe as the pieces of coral rock are forced through. Occasionally a large jagged piece of rock will

tear through a leather joint and then the mud spurts.'

* * * * * * *

"I had charge of this particular work and the dredge referred to is the dredge 'Babcock.' The flexible joints were made of rubber instead of leather and only occassionally was there a piece of rock forced through the pipe."

WITNESS IDENTIFIES THE HUSSEY PATENTS AS CORRESPONDING TO THE DREDGERS.

(R. 265):

"L. Hussey No. 526,530 is similar to the plant on the dredges 'Babcock' and 'Rough Rider.' No. 497,427 indicates that this plant is operated by compressed air, while the dredges 'Babcock' and 'Rough Rider' were operated by steam."

(R. 266):

"The drawings are typical of the type of machines used on the dredge 'Babcock' and 'Rough Rider.'"

Capt. Geo. T. Warner (now 73 years old) testified (R. 277):

"I was connected with the Babcock-Lary Dredging Company from 1896 until, I should think, about 1902 or 1903, as I remember."

(R. 278-9):

"The dredge 'Babcock' was built in New York somewhere shortly prior to 1896 and operated for several years on Long Island, New York, and in and about New York. The dredge 'Rough Rider' was built at Massena, New York, did some work up there, which I had nothing to do with, was then brought down to New York and later on

brought to Savannah, Georgia. Both dredges, the 'Babcock' and 'Rough Rider,' were under my control in Savannah, Georgia. They were used in the river to build the Seaboard Air Line Terminal—freight terminal—and we built three slips into the marsh with those two dredges, principally the 'Babcock.' The first slip was 1500 feet long; that is, from the river bank; the second slip was 1000 feet long, and the third slip was 800 feet long. Each of them was about 200 feet wide. The river we widened opposite the City of Savannah 135 feet, I think—as well as I can remember, 27 years ago. 1899 we commenced work and I think we finished that work there in 1902.

* * * "at Savannah * * * the 'Babcock' had one vacuum pump. The 'Rough Rider' had two. The 'Rough Rider' was built with the intention of using the pumps alternately; while one pump was being emptied, the other would be filling. We found that didn't work first rate, so we only used one pump on the 'Rough Rider.' The 'Babcock' was used with one pump altogether.

"We handled everything under the sun with the 'Babcock' at Savannah. We picked up skulls, Spanish money, buttons off the coats of Revolutionary British soldiers, rock, sand, everything else—watches—everything we found in that pump. The river and these slips that we dug in were on an old rice field opposite the City of Savannah—that the British soldiers were in camp during the Revolutionary War, and it was the remains that a great many of the old camps left there that were disturbed. We dug up a number of wrecks and of old British gunboats. We recovered old British muskets which fell to pieces with the rust when we picked them up. We picked up old cannon and almost everything that you can name.

"The 'Babcock' had a 15-inch discharge pipe and the 'Rough Rider' an 18-inch discharge pipe. We could not put everything through the 'Bab-

> cock' pipe of 15 inches that was anywhere from six to eight or ten inches. I did know of some pieces of rock going through that were **twelve inches in diameter.**
>
> * * * * * * *
>
> "Savannah was a naval stores port. Foreign vessels would come in there for the purpose of loading with naval stores. They would come in ballast. That ballast was thrown out largely at the point where we dug Slip Three, and it was said that a man of any nation could go ashore on that dump and stand on his native soil, meaning, in other words, that vessels from all over the world came there and loaded naval stores."

This accords with the published articles in periodicals of the time.

Exhibit 121: "Engineering News," June 13, 1895, page 378.

Exhibit 122: "Engineering News," June 13, 1895, pages 384-7.

Exhibit 123: "Engineering Record," Jan. 6, 1900.

Exhibit 124: "Transactions of A. S. C. E.," Jan. 1894, pages 70-71.

Exhibit 125: "Transactions A. S. C. E.," May 1894, pages 492-3.

The first of these exhibits relates to the Hussey delivery dredge such as shown in the Hussey patents in evidence and referred to by the Miami witnesses and described by the Miami witnesses, and the other articles relate to similar operations of pneumatic dredges, but they may be considered together.

They all go to show the force and power of air under compression for the moving of any mobile substance that it can get behind or come in contact with.

Exhibit 121 gives an admirable illustration of the Hussey dredge and its mode of operation.

The article says, page 380:

> "At the time of our visit the length of discharge pipe was about 2500 feet and the dredge was handling **about 500 cu. yds. per hour.** * * * The material being handled was composed of **sand, gravel and mud,** about 70% being sand and the discharge from the delivery pipe approximates about **50% of solid** and 50% water."

MATERIAL MORE DIFFICULT OF HANDLING THAN CONCRETE.

It refers to Babcock, Lary & Co. builders. Continuing:

> * * * "at Orange Lake, Newburg, N. Y., where the material was **transported 2,500 feet in 15-in. pipes,** reaching an **elevation of 44 ft.,** the material as delivered containing approximately about **75% solid** and 25% water. The same dredge has for a year past been doing successful and satisfactory work in handling pure sand at Bergen Beach, N. Y. The dredge referred to in this article was constructed later, and did its first work at Rye, N. Y., where it was required to handle **gravel, stiff clay, sand and stones** which **could scarcely pass through an 18-in. pipe,** delivering these materials through 1035 ft. of pipe and raising them 25 ft. in this distance. **One of the many large stones was 16x21x10 ins., and was forced through with a pressure of 12 lbs. of steam. Large stones** and other heavy articles can be passed without injury to the pipes."

In Exhibit 124, in referring to vacuum steam pressure pumps and dredges of the sort used in reclaiming the Potomac Flats, it is said, page 71:

> "The ability of this pump to handle heavy objects was demonstrated on two occasions; **at one time a stone, supposed to be a buoy anchor, weighing 1300 lbs., and at another time, an iron safe, 25x16x14 ins.**, were forced through it."

Certainly if the apparatus could handle stuff like this the blowing of ordinary concrete would be mere child's play.

In Exhibit 125 there is a discussion of dredging operations in 1894. The operation is succinctly given as follows:

> "The operation was this: The bucket lifted the material into the bin, the vacuum was formed in the usual manner, the inlet gate was lifted, and the charge filled the chamber. Then the inlet gate was shut, the outlet gate was opened, steam was let in, and the muck was driven to the dumps. **The material was almost wholly muck, varying from a consistency of peat to light, fibrous material.**"

DEPOSITIONS AT SULPHUR, LA., (R. 155-197).

These depositions had to do with the subject-matter of the once famous litigation over the Frasch patents —*Union Sulphur Co. v. Freeport & Texas Co.*, 255 Fed. 963 (3 C. C. A.).

Sulphur is a very difficult substance to deal with. It begins to liquify only when heated to a temperature above boiling water around 250° F., while if it is heated to over 313° F. it begins to become pasty so that it will not flow. Consequently, piping sulphur through long lines, particularly by means of air

pressure, the sulphur must be kept within a narrow range of high temperatures.

Melted sulphur is twice the weight of water.

CONVEYING MOLTEN SULPHUR BY COMPRESSED AIR.
FRASCH NO. 799,642, SEPT. 19, 1905.
(Application filed May 27, 1897.)
NO. 800,127, SEPT. 19, 1905.
(Application filed Nov. 23, 1903.)

These patents are outstanding examples of the handling of a heavy, viscuous substance far more difficult than concrete, by compressed air. The litigation over these patents makes them doubly significant in connection with the present suit.

Union Sulphur Co. v. Freeport & Texas Co.,
255 Fed. 963 (3 C. C. C. A.),

where these patents, despite their wonderful contribution to the industry, were held invalid in this very **air conveyor feature!**

Mr. Keever, vice-president of the Union Sulphur Co., tells us molten sulphur was pumped from a depth of from 500 to 1400 feet. (R. 158.)

COMPRESSED AIR THE ONLY PRACTICAL METHOD.

Mr. Keever further testifies (R. 165):

"Q. What method was used to bring all this sulphur to the ground?

A. The compressed air method.

Q. What other practical method, aside from the compressed air method has been used by the Union Sulphur Company to bring sulphur to the ground?

A. There was no other practical method.

Q. Do you know of any other practical method used by any other company?

A. I do not; I know that the Freeport-Texas Company are using compressed air in their wells."

DIFFICULTIES OF HANDLING SULPHUR.

Mr. Keever testifies (R. 166):

"Q. Is sulphur easier to convey or lift by compressed air than water, or any other substance you know of, or is it harder?

A. It is harder to convey than water because it is heavier, but if sulphur is kept at the right temperature, I can see that it can be no easier or harder than other flowing substances of like density or specific gravity."

The magnitude of these sulphur pumping operations by compressed air is shown by the number of wells pumped prior to 1907, and the millions of tons of sulphur so handled could be handled or recovered by no other known method.

"SLUG" OR "PISTON" ACTION ALWAYS PRESENT IN PUMPING SULPHUR.

Mr. Keever thus refers to the "piston-action" of pumping sulphur:

"A. It comes out intermittently, by gushes, slugs, or pulsations.

They vary from seven or eight up to twenty-eight per minute. It depends on the amount of sulphur that the well is producing." (R. 169.)

"A. It always came, so far as I have been able to observe, in the same way, in pulsations. * * *

Where a well was only making a few gushes, from ten to fifteen, it would be pumping a very small quantity of sulphur, but if it pumped up to twenty-eight gushes per minute, it would make from five to six hundred tons in twenty-four hours."

Mr. Maxwell says (R. 189):

"A. It is nothing more or less than a gush of sulphur, and that is gauged by the volume of air coming up through the three-inch pipe with sulphur."

(R. 181):

"Q. Who was the man who first used compressed air to produce sulphur, as far as you know?

A. Herman Frasch.

Q. And you yourself have used it since coming to the Sulphur Mines?

A. Since 1902; were using compressed air when I came here in 1902. I was here in 1902 and 1903 and saw the compressor running."

Again Mr. Maxwell says (R. 187):

"My earliest experience in observing the pumping of wells by compressed air was in May, 1903. The sulphur came out of the ground from these wells in liquid form, coming out in gushes or slugs, I would call them. I first observed this pulsating action of the sulphur coming out in gushes in May, 1903. There was no difference at all in the way in which the sulphur came out of the ground in 1903 and 1907, or even later on. Compressed air was used in both years."

Mr. Keever says they also pumped mud and water and with the mud they also noted the **gushing action** (R. 178-9).

Only Necessary to Add Cement to Make Concrete.

Mr. Maxwell testified (R. 193):

"RDQ. You testified that you saw them pump sand, water and gravel by compressed air, what would you have to add to that to make concrete?
A. Cement."

FRIZELL AND POHLE METHODS CONTRASTED.

It might be here explained that as early as 1890 there were two well-known methods of lifting and conveying liquids and semi-liquids by compressed air, commonly referred to as the "air-life" method of pumping. According to one method (the "Frizell method") see Frizell patent of 1880,* (R. 367), the air was mingled with the liquid in the form of minute bubbles so as to form a **foam,** or column of mingled air and liquid of diminishing density, so light that it would be raised by the available pressure in the ground.

According to the other, or "Pohle method," the air was injected in bulk so as to form a series of **pistons** ("slugs") alternating with **pistons** of liquid. This Pohle or **piston** ("slug") method is described in the Pohle patent No. 487,639, which is reproduced (p. 565 Exh. Bk.)

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*Frizell, No. 233,499, Oct. 19, 1888. (Deft's Exh. 163 p. 636 Exh. Bk.) This early patent is generally taken as the leading exponent of the aeration method of raising liquids or semi-liquids by compressed air. The invention is aptly expressed in his claim: "In the art of elevating water, the method of causing a column of water to ascend in a conductor by the weight of the external water, which consists in introducing a tube of the desired length at the required depth into the water to be elevated, and then injecting compressed air in the form of minute bubbles into the water at the lower end of said tube, thereby aerating the water, whereby a continuous stream is caused to flow upward to the point of discharge, substantially as described."

The Frasch sulphur patents represented a combination of both ideas. **These Frasch patents although they wrought a revolution in deep sulphur mining, were nevertheless held void for lack of invention.**

CROWLEY, LA., DEPOSITIONS (R. 197-218).

These depositions were of leading citizens of the community and pertain to early practical work in lifting and conveying sand and water, oil, etc., by compressed air. It was as to work similar to that testified to by Mr. Ivens, supra.

The first witness was Mr. H. J. Landers, vice-president of the Acadia Iron Works, who has lived in that community for about 34 years. He stated that in about 1895 or 1896 he was engaged in rice farming down in Vermilion Parish, and that he decided to put in a deep well and raise or pump water by compressed air (R. 198).

The witness says (R. 198-99):

> "After our well caved in on us it was useless and we disposed of it to the **Crowley Brick Company,** I believe it was * * * It was pumping sand the same as it pumped water. They used the same principle, **compressed air forced the sand to the top and lifted the sand out."**

(R. 200):

> "The sand came out of the same size pipe as the water, about an eight-inch pipe."

The next witness is Mr. John Green, Wholesale Grain Merchant, who was a director of the Crowley

Brick Company which had a short existence from about 1901 or 1902 to 1904. Concerning the consistency of the material pumped, Mr. Green testified, on cross-examination (R. 205):

> "Why I would say it was at least **seventy-five per cent sand. It seemed to be almost solid sand just running out of the pipe. There was water mixed with it.** It was so much sand it would kind of pile up,—if there had been so very much water it would have washed away."

The next witness was Mr. J. G. Medlenka. He is 57 years of age, a lawyer by profession, and was **President of the Crowley Brick Company** during its existence. Concerning the use of air for conveying sand, water and gravel, Mr. Medlenka testified (R. 208):

> " * * * The idea was to have the sand and gravel flow into the end of the casing and as it flowed it was pumped out by the compressor. Of course, **water, sand and gravel** came in together.
>
> * * * * * * *
>
> "* * * This **sand and gravel, together with water, was forced to the surface** and at the top there was an elbow on the end of the pipe that shoved it out on the land away from the derrick."

Mr. Jack Frankel, president of the Bank of Acadia and of several other institutions, is 65 years of age and has been in Acadia ever since the town started 40 years ago. He was a director of the Crowley Brick Company in 1902-1903.

Speaking of the consistency of the sand, gravel and water he says (R. 217):

> **"It came out in mulsified form,—a pretty thick liquid."**

(R. 218):

"No sir, **the sand was mulsified very strongly with the water. It was pretty thick.** It came out in gushes acting on the impulses of the machine."

DEPOSITION OF EDMUND M. IVENS, NEW ORLEANS, TAKEN SEPTEMBER 1, 1927, A NOTED ENGINEER IN WATER LIFT WORK.

Mr. Ivens is one of the most distinguished living authorities on the use of compressed air for moving liquid. A text-book of his is in evidence as defendant's New Orleans Exhibit 12 (R. 251) entitled "Pumping by Compressed Air" (1914). Also author of a number of technical papers on the subject (R. 221-222). Mr. Ivens shows his qualifications and experience in a great many different industries and instances. He also refers to his experience with apparatus of the type shown in the Harris patent, No. 814,601, and of which Harris patent he made a drawing which is in evidence as defendant's New Orleans Exhibit 9 (R. 235), **wherein the air chamber in the well is sealed so that an air pressure could be created on top of the water in the well; and in addition thereto there was a jet of air or booster jet at the bottom to aid in ejecting the liquid.** Thus there was **a combination of the two air pressures or air jets just as in the McMichael patent.**

Mr. Ivens shows that the pressure on top of the material in a closed receptacle (as in McMichael) is the counterpart of the hydrostatic head of the water column surrounding the discharge pipe of an air lift.

WIDE VARIETY AND USE OF AIR LIFT.

Mr. Ivens testifies (R. 246-247):

"Q. To what extent is the system of pumping by compressed air used, both in this region and elsewhere?

A. Very largely used in such industries as ice plants, waterworks plants, electric light plants, sawmills, sugar factories, oil refineries, hotels, office buildings, and in almost every industry located inland where surface waters are not available.

* * * * * * *

"A. In this locality, air lift is used in elevating **water, oil, sulphur,** and, in some instances, **solids** like grain."

NO DIFFERENCE IN ACTION WHATEVER THE MATERIAL.

(R. 250):

"Q. State what difference there would be in the operation as previously described by you, in the case of sand and gravel?

A. There would be no difference in the actual operation of the air lift."

On cross-examination Ivens testified (R. 252-53):

"A. The largest percentage of sand pumped with fluid was in oil wells, and, of course, there is a wide variation. I have seen possibly as high as **eighty to ninety per cent** sand handled in fluids."

ABSTRACT OF EXHIBIT PUBLICATIONS.

EXHIBIT 20: Engineering Record, Oct. 20, 1906.

EXHIBIT 21: Penna. R. R. Gazette, April 20, 1916.

EXHIBIT 22: Engineering-Contracting, Oct. 16, 1907.

EXHIBIT 23: Scientific American, May 18, 1907.

EXHIBIT 24: "The Railway Age," April 19, 1907.

These exhibits all have reference to the building and progress of work on the Key West extension of the Florida East Coast Railway testified to by the Miami witnesses.

Certain of these articles refer to the use of the pneumatic dredgers by which the marl or coral rock and water was forced by steam pressure long distances through pipes; and shows the advantage of these types of dredgers over the suction and other types of dredgers.

These articles indicate not only the magnitude, but the tremendous difficulties of the job.

In Exhibit 22, page 633, it says:

> "The coral rock on which a considerable portion of the roadbed is based, makes an excellent foundation, the same material crushed affords excellent ballast. As before stated, this crushed coral becomes as hard as rock, after exposure."

PNEUMATIC SEWAGE SYSTEM.

EXHIBIT 27: "Transactions of the A. S. C. E., Dec. 1892, pages 659-666"—

showing and illustrating a method of conveying sewage by air pressure.

The principle and mode of operation are well illustrated on pages 662 and 663.

> "The compressed air thus automatically admitted into the injector presses on the surface of the sewage, driving the whole of the contents

before it through the bell mouth opening at the bottom and through the outlet pipe B into the iron sewage discharge pipe or high level gravitation sewer, as the case may be."

The apparatus illustrated in section is not so unlike the McMichael device.

GROUTING BY COMPRESSED AIR.

EXHIBIT 28: Proceedings of the S. C. E., 1896.

EXHIBIT 52: Engineering News, Oct. 11, 1906.

EXHIBIT 53: French "Revue Generale," pages 529, 539 (1906).

EXHIBIT 55: Engineering News, Nov., 1909.

EXHIBIT 56: French Revue Genrale, March, 1909, pages 171-174.

EXHIBIT 58: "Zentralblatt," Feb. 21, 1891, pages 73-75, and Feb. 28, 1891, pages 84-85.

EXHIBIT 62: German "Zentralblatt," Oct. 17, 1903, pages 517-518.

EXHIBIT 82: Copperthwait, 1905, pages 94-5.

EXHIBIT 83: Caniff Patent No. 873,345.

EXHIBIT 88: McIlvrid Patent No. 95,421, May 17, 1910.

EXHIBIT 89: Boston Tunnel, May, 1902.

EXHIBIT 90: Belmont Tunnel, N. Y.

EXHIBIT 92: Engineering Record for June, 1907.

EXHIBIT 100: Cockburn Barrow Co., Catalogue C, 1905.

EXHIBIT 103: Transactions of A. S. C. E., Sept., 1910 (Pennsylvania Tunnel McIlvrid Machine).

In EXHIBIT 28, of 1895, and EXHIBIT 82 of 1905, the work of the distinguished engineer, Greathead in the use of grouting by compressed air is described at some length.

The first exhibit refers to the added advantage of tunnel ventilation where compressed air grouting was used.

EXHIBIT 82 describes further and illustrates the Greathead grouting pan which latter in many ways foreshadows the American patent of McIlvrid.

Greathead's British Patent is No. 5221/1886.

EXHIBIT 103 illustrates the mode of use of a McIlvrid machine as practiced in Pennsylvania tunnels.

EXHIBIT 33: March, 1898, page 403.

Compressed Air Dredger for Gold Mining:

This is a description of the Rix & Donahoo patented machine. It handles material very similar to concrete pipe and very similar to the McMichael Method by compressed air.

Thus the writer says:

> "In general, as shown above, these machines are iron caissons, which can be raised or lowered through the center of a boat or barge, the water being expelled by the proper pressure of compressed air. The bottom is thus exposed to the direct manipulation of the miner who is within

the caisson, and he picks or otherwise loosens up the earth or gravel on the bottom and sends it to the surface through the small internal discharge pipe, either by direct air or water pressure as he desires. * * * No bad effects upon the operator are produced as the pressure is moderate and invigorates rather than depresses the worker."

"Men work in caissons at 25 to 30 pounds pressure per square inch, which corresponds to 60 or 70 of water pressure."

"The machine is intended for such rivers as the Yukon and is manufactured by Rix & Donahoo, San Francisco."

EXHIBIT 34: January, 1902, pages 1655 to 1659: Discussion of the Pohle Air Lift System in pumping water at the Government Hospital, District of Columbia, from a depth of from 200 to 300 feet, using Ingersoll-Sergeant compressors.

On page 1658 is another article on the use of the air lift describing its various other applications. Thus:

"In addition to its use for raising water, compressed air lends itself with remarkable facility to the difficulties involved in handling brine from salt wells, for raising sulphuric acid, acid solutions, and other commercial liquids of high specific gravity and corrosive character. In manufacturing establishments, it is indispensable for ore leaching, handling dye, paper, pulp and fluids. In sugar refineries or any place where gritty particles and chemical solutions are encountered and for many other purposes which will suggest themselves the Air Lift has no equal."

EXHIBIT 35: Vol. 7, 1902, pages 1941-2-3:

An article entitled "Removing Sand from Wells by Compressed Air."

The article says:

> "The idea of this was not only to blow the sand out of the well by stirring it up and carrying it off by the large flow of water due to the action of the air lift, but also to make such action sufficiently violent to knock any rust off the perforations. * * * The result of this was to bring up a steady stream of water containing much sand and large pieces of rust. * * *"

On page 1943 is a picture of the well blowing out sand and apparently large rock.

EXHIBIT 36: March, 1903; September, 1903; October, 1903.

These cover articles on conveying sewage by pneumatic pressure and on conveying tailings, sand, cyanide concentrates, etc., in mining.

On the elevation of tailings the author said:

> "The rising main was a 4-inch black pipe with air inlet through 1-inch pipe. This elevator was capable of lifting tons of tailings in 24 hours. The most wear was shown on the top bend which has a life of about six months. In the rest of the pipe the wear was normal."

EXHIBIT 37: January, 1904, pages 2723, 2735.

This is an extended article on the raising of water with compressed air, being a reproduction from the "Engineering Times," London.

It describes the various apparatuses and uses, including the displacement pumps, the Frizell bubble method shown in the Frizell 1878 patent, and the Pohle method of slugs or pistons here claimed as new by plaintiff and refers to the distinguished Dr. Siemen's work in the air lift pump line, and also refers to various publications in German and French on the subject.

It quotes an earlier authority as follows:

> "The mixture of air and water in a vertical pipe forms a kind of froth having a less density than water, thus allowing it to be raised to the surface where it flows out."

EXHIBIT 38: May, 1904, pages 2911 to 2922.

This article gives any number of uses that compressed air was being put to as early as May, 1904, in lifting and conveying various substances.

Among other things it refers to the sand blast, to painting by compressed air, lifting water, etc.

EXHIBIT 39: June, 1904.

Here we find one of the earliest descriptions of the McIlvrid grout mixer.

This is a horizontal type of machine—shown in the McIlvrid patent, and has been in extensive use for the past 23 years.

The mixture used was 3 bags of cement, 3 bags of crusher dust mixed with a suitable quantity of water.

After mixing "air pressure of 90 pounds is admitted to the cylinder and forces the grout through a 2-inch outlet in the bottom and a flexible hose connected with the 1¼-inch hole in the tunnel shell."

EXHIBIT 40: January, 1905, page 3320.

An article on the use of compressed air for painting.

EXHIBIT 41: February, 1905, pages 3347 to 3349.

An article descriptive of an air-lift pump of the Pohle piston or pulsating type.

Refers to the difficulties Mr. Pohle had in convincing the Patent Office of the novelty of his theory, and also refers to an article by Mr. E. A. Rix describing the pump in the Journal of the A. E. S., Oct., 1901, page 201.

EXHIBIT 42: December, 1905, pages 3792-3796.

This is an article on the pumping of wet sand by compressed air.

Considering the operation, the article says:

> "A constant flow of water which enters the pit on all sides * * * is collected in a sump * * * and the mixture of sand and water is directed into a box beside the main pump. From the sump the sand and water are delivered into a tank * * *. The sand and water (in the tank) is discharged by compressed air * * * through the delivery pipe * * * the sand mixture varies in quantity from 5 per cent of sand to 65 per cent by weight. The average performance of

the pump is 50 tons of sand alone raised per hour or 500 tons of sand per 10-hour day."

On page 3795 the article says:

"the introduction of this pneumatic system of pumping in the pit has been the solution of a serious problem which was confronting all sand producers of that section."

EXHIBIT 43: February, 1906, page 3897.

This illustrates a compressed air white-washing machine.

The article says that the machine "accomplishes in two hours the amount of work that can keep one man busy a month."

EXHIBIT 44: September, 1903.

This article describes a pneumatic tamping device that has been put in practice on the Erie Railroad and refers to its earlier use on the Chicago N. W. and N. Y., New Haven.

The method here shown apparently differs from the Goldie patented method of using wet concrete as apparently it refers only to blowing broken slags.

The article says:

"The ballast used was broken slag. In surfacing the track the desired end was secured by blowing pulverized slag in the ends of the ties to fill the space caused by lifting the rail to grade. * * * The idea of tamping tracks by blowing fine gravel or other material under ties with an air blast is by no means new."

Note: This was as early as September, 1903, the date of the article.

EXHIBIT 45: April, 1903.

This describes several new blast machines employing both the syphon jet and the pressure jet singly or combined, just as in McMichael.

EXHIBIT 46: June, 1897, page 234.

This describes a Ballast Injector quite similar to that described in Exhibit 44. It employs a hopper and flexible hose and a blower and a "double tubed injector."

EXHIBIT 47: June, 1896, Vol. 1, No. 4, page 3.

Referring to the then recent St. Louis tornado the article says:

> "Perhaps the most impressive evidence of the storm's force is shown in the wrench given to the eastern end of the Eads bridge. There the tornado dealt with stone masonry. It tore off and tumbled down tons upon tons of this masonry. Beginning with the big eastern pier and extending to the foot of the incline, the tornado cut off the upper part of the structure as if it had been of flimsy trestle work.
>
> What power is this which is exhibited with such marvelous intensity? * * * The power of air exerted in this mysterious manner indicates that there is something unknown in this line which has not yet been properly defined."

EXHIBIT 50: June, 1907, pages 4490-4491.

This is an article on sand blast on high and low pressure type and illustrates a structure almost iden-

tical in construction with the Ransom-Caniff concrete placer in using a blast on top of material in the tank and a syphon jet at the bottom. The only thing needed to make it a McMichael-Ransom-Caniff gun is to increase the size of the device.

COMPRESSED AIR FOR INJECTING CEMENT INTO QUICK-SANDS AND FOR CONSOLIDATING FOUNDATIONS.

EXHIBIT 51: Engineering Record, March 29, 1913—Grouting a Fissured Foundation in the Carson River, Nevada Country.

EXHIBIT 62: "Zentralblatt," 1903.

EXHIBIT 63: Translation of Exhibit 62.

EXHIBIT 106: Transactions of the A. S. C. E., Sept., 1893, by Neukirch.

EXHIBIT 109: Transactions of the A. S. C. E., Dec., 1893, "Subaqueous Foundations," by Neukirch.

EXHIBIT 115: Engineering News, Sept. 15, 1895, Pohle 163: "A New Method for Securing Foundations."

EXHIBIT 116: French publication, "Le Genie Civil," Sept. 21, 1895, page 327.

EXHIBIT 117: Translation of Exhibit 116.

EXHIBIT 118: French publication, "Le Genie Civil," Dec. 29, 1900, page 145.

EXHIBIT 119: Translation of Exhibit 118.